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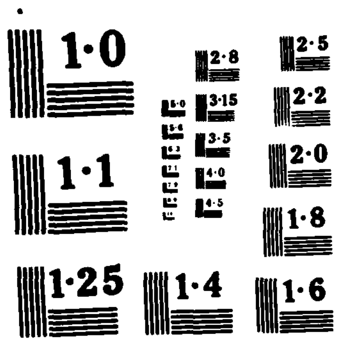
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SIR-B IMAGES

31 May 1985

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INTRODUCTION

This is the final report on Contract Number N00014-84-C-0716 under which we were to arrange for, secure, and analyze selected synthetic aperture radar (SAR) images from Space Shuttle Mission 41G. The mission occurred during 5 October to 13 October 1984 and was beset by serious technical difficulties that, as it turned out, precluded any useful analysis on our part.

MISSION SYNOPSIS

Space Shuttle Mission 41G was launched from Kennedy Space Center on 5 October 1984. Aboard the instrument pallet was the 1.28 GHz (L-band) Shuttle Imaging Radar (SIR-B) intended to obtain SAR images for geology, agriculture, forestry, hydrology, and ocean sciences. Data were intended to be transmitted to earth via a K_u band communication link with the Tracking and Data Relay Satellite (TDRS). Unfortunately, the shuttle's trainable K_u communication antenna failed to lock onto the TDRS, making high rate data transmission impossible. A real-time-revised observation program, of much smaller scale than the original plan, was substituted making use of an on-board tape recorder. The flight crew recorded radar data on the recorder and then reoriented the shuttle itself, with the K_u antenna fixed, to point to TDRS and transmit the data. The revised plan eliminated about 80 percent of the planned data swaths and shortened the remainder. A number of errors crept into the SIR-B experiments as a result of the sudden and complete reprogramming as well as a problem in latching the radar antenna. Finally, an electrical problem in the radar caused an 8-10 dB reduction in signal-to-noise ratio.

DATA

Original plans, coordinated with NASA/JPL and Navy commands, called for radar images to be obtained on orbits 50, 64, 80, and 96. The swath location for orbit 50 was moved substantially in the reprogramming (as a result of another Navy experiment) precluding use of that orbit for our purposes. The NASA/JPL post-flight report indicated that the radar on orbit 80 was turned off 18 seconds (131 km) before it reached the location of our interest. However, the post-flight report indicated that the desired data were obtained on orbits 64 and 96, so we proceeded to work with Naval Research Laboratory (NRL) personnel to locate and process images from these orbits.

Rev. 64

The only way to accomplish accurate geolocation (the precise establishment of the earth coordinates) for a SAR scene over the ocean is to find an identifiable land scene on the same swath and project the position and timing of the subsequent (or preceding) portions of the swath. This procedure was complicated for Rev. 64 because the radar antenna was pointed at a different angle during landfall than it was over the ocean. After considerable unsuccessful efforts on the part of the NRL personnel, an identifiable land scene was found in the Rev. 64 data in the form of the Roanoke River near Oak City, North Carolina. By using the geographical location and signal time for this scene, and correcting for the antenna angle shift, locations of the subsequent swath could be projected to an estimated accuracy of ±2 km in cross-track location

and ±3 km along-track. (It was found that the NASA post-flight timing was off by 16 seconds on Rev. 64.) These location accuracies were verified later when the tip of Nantucket Island was found in the edge of a later scene from Rev. 64.

Unfortunately, the derived swath location for Rev. 64 was found to be displaced 13 km cross-track (southeast) from the pre-flight (and in-flight) plan. Apparently, the data window of the recorder was mis-set during this pass. The useful half-width of the swath is limited by bandwidth limitations to 10 km so that a location in the center of the pre-flight swath would have been 3 km beyond the actual swath. The location we were interested in turned out to be 8 km off the swath.

Rev. 96

Geolocation for this pass was accomplished in a manner analogous to that discussed for Rev. 64. In this case, a scene at the head of Albemarle Sound near Edenton, North Carolina, contained the confluence of the Roanoke and Chowan Rivers. No correction for radar pointing angle was necessary as the antenna was not moved between landfall and open ocean. It was found that the actual swath closely followed the pre-flight plan. However, when the data tapes were run, it was found that the signal actually terminated 16 seconds (or 117 km) short of the location we chose. The high density tapes recorded independently at the Johnson Space Center and at the Goddard Space Flight Center both were searched for signal data. It was found that both terminated signal at the same time, indicating that the radar was turned off prematurely.

CONTRACTOR ACTIVITIES AND TASKS

Task 1 of our proposal called for liaison with NASA to select candidate revolutions while Task 2 involved coordination with Navy operational commands. Both tasks were accomplished successfully with both ORI and its subcontractor, Mandex, Inc., participating in both tasks. The reprogramming during the flight necessitated our participation in the real-time planning activities at NRL, which served as the focus for all Navy-related experiments in the mission.

Task 3, analysis of selected scenes, could not be accomplished because no scenes of interest were imaged by the radar, for reasons discussed above. However, a more-than-equivalent amount of effort was expended in working with NRL in an attempt to extract useful images from the available data, as described above.

ACKNOWLEDGEMENT

It is clear that dedicated and extraordinary efforts were made by the Systems Control and Research Branch of NRL's Radar Division in attempting to salvage information from an otherwise flawed experiment. In particular, Dr. Charles S. Weller served as our point-of-contact and accomplished much of the effort mentioned herein.

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